Citation:

LeBlanc DI, Goguen B, Dallaire R, Taylor M, Ryan D, Klassen M. Evaluation of thermometers for measuring the cooking temperature of meat. *Food Protection Trends*. 2005; 25(6): 442-449.

Study Design:

Randomized block trial.

Class:

A - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

Six models of fork thermometers/indicators and six models of digital instant-read probe-style thermometers were evaluated to determine their accuracy in measuring a safe end-point temperature.

Inclusion Criteria:

- Six units per model of six models of fork thermometers/indicators and six models of digital instant-read probe-style thermometers were purchased from Canadian department stores
- Based on an evaluation of accuracy done in a heated water bath, four models of fork thermometers/indicators and four models of digital probe thermometers found to be the most accurate or reliable were selected for further testing in the beef patties and the roasts.

Exclusion Criteria:

None specifically mentioned.

Description of Study Protocol:

Recruitment

Selection criteria for thermometers was not described.

Design

Randomized block trial.

- A water-bath evaluation was conducted to determine the most accurate of the thermometer/indicators. The devices' results were compared to the results of a thermocouple in a water bath. The eight most accurate devices were then tested in pre-formed beef patties and roasts.
- Preliminary tests were conducted to determine the most reliable method for measuring the

temperature of beef patties and roasts. An accurate temperature reading could not be obtained during any of the tests in which the device was inserted from the top of the patties. All experiments were conducted with the temperature measuring devices sideways into the beef patties, and 3.0 cm into four different axes of the roasts.
- A standard procedure was used for cooking all of the meat samples. Sixteen batches of nine beef patties were cooked. When the center temperature reached 71 ºC (by thermocouple), it was removed from the grill and the temperature measured. Two units of each of the devices were randomly assigned to one of the burgers in each batch, and inserted into the side of the patty. The temperatures or doneness shown on the device was noted, along with the temperature of the reference thermocouple.
- The roasts were cooked to a center temperature of 68ºC by thermocouple measurement, then removed from the oven. The thermometer/indicator devices were inserted on four axes and the temperatures noted.

Statistical Analysis

The differences between the temperature measuring devices and the reference thermocouples were statistically analyzed.

Data Collection Summary:

Timing of Measurements

All of the measurements done following standard procedures during one session for each type of meat.

Dependent Variable

Accuracy of end-point temperature measurement of cooked beef patties and roasts.

Independent Variables

- Four models of fork and four models of probe thermometer/indicator devices
- Since two of the forks showed degree of doneness only, the lowest temperature of the range was used for analysis. For example, "well" represented a temperature range between 64.5ºC and 79ºC, so 64.5ºC was recorded for a measurement in this range.

Description of Actual Data Sample:

- *Initial N:* 16 batches of nine beef patties were measured; 60 measurements were taken on roasts
- *Location:* Canada.

Summary of Results:

Key Findings

- When the thermometers were evaluated while cooking pre-formed beef patties and roasts, fork thermometers and digital read thermometers underestimated the temperature of the

cooked foods by 1°C to 11°C (1.8° to 19.8°F)
- However, when the thermometers were correctly used according to manufacturers' instructions, such as proper placement in the food for a specified time (at least 30 seconds), the analog and digital thermometers provided reliable information on cook temperatures
- Beef Patties:
  - The individual models of fork thermometers underestimated the temperature of the beef patties by 3°C on average
  - The digital probe thermometers underestimated the temperature by 2°C
  - The larger deviation with the fork thermometers may be the result of use of ranges or "doneness" method for estimating cooking temperatures. With two of these fork thermometers, incorrect doneness was always underestimated, resulting in slightly overcooked meat. In another model, 60% of the time temperatures were underestimated, but 20% of the time they were overestimated. Overestimation could result in meat patties not reaching a high enough temperature to ensure food safety.
- Beef Roasts:
  - Models of fork thermometers underestimated the temperature of the roasts by 4°C on average, while the digital probe thermometers underestimated the temperature by 1°C. The thermometers that underestimated the most were models that did not show a temperature, but only a doneness value, probably the result of recording the lowest temperature in the doneness range.
  - The mean temperature difference between each temperature measuring device and the reference thermocouple was similar in the roasts and the patties
  - The temperature shown on the display of the devices increased very rapidly in the first five to 10 seconds, but then took much longer to stabilize to the actual temperature of the meat. After 30 to 45 seconds, the device showed a temperature within 94% to 98% of the total temperature increase.

Author Conclusion:

Author recommendations:

- To obtain accurate temperatures with fork and digital probe thermometers, the devices must be used properly:
  - Insert from the side in thin cuts of meat so that at least 3cm to 4cm of the probe are in the meat
  - Measure temperature within one minute of removal from the heat
  - Leave the thermometer in the meat for at least 30 seconds before reading the temperature
  - Include these instructions on the device packaging
- When cooking on a grill, due to uneven heating, measure the temperature of each patty to be sure each has reached the required temperature
- The ideal fork thermometer should have a digital temperature display, tines about 6cm long and less than 0.5cm diameter. The total length should not exceed 30cm. None of the tested devices met these criteria. Digital probes should have a probe length of at least 8cm and a diameter of less than 0.5cm. All the probes tested met these criteria.
- The thermometer response time should be as short as possible. Thermometers with doneness indicators are not recommended for beef patties.

Reviewer Comments:

Selection criteria for thermometers were not described, but six units per model of six models were studied. Statistical analysis was not described.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes
Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes

3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	N/A
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes

6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	???
8.1.	Were statistical analyses adequately described and the results reported appropriately?	No
8.2.	Were correct statistical tests used and assumptions of test not violated?	???
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A

8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	N/A
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	???
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes